FUZZY SYSTEM PROJECT REPORT

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Recursive Least Squares Algorithm

Fuzzy Systems Course

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Designing Fuzzy System using Recursive Least Squares Algorithm Report.

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In this technique, like the Gradient Descent technique, we must first specify the structure of the fuzzy system, then update the centers of the output membership function (y^l). The details of our fuzzy system are as follows:

- PIE
- Singleton fuzzifier
- Center of Average defuzzifier
- Optional membership function

Rule Base

Like the Table look-up technique, we have to create a rule base here, and it must be a complete rule base. We make our rule base with this code:

```
PR = prod(MFN);
Repeat = 1;
Rules = zeros(PR,InputNum);
for i=1:InputNum
    PR = PR/MFN(i);
```

```
        for l=1:Repeat
            for k=1:MFN(i)
                for j=1:PR
                    Rules(j+(k-1)*PR+(l-1)*PR*
MFN(i),i) = k;
                end
            end
        end
        Repeat = Repeat*MFN(i);
    end
```

We should initialize parameter θ, using the same initialing method as online initial parameter choosing. Then we must update our parameters as below:

```
for p=1:size(Pairs,1)
    b_x = CalculatingB(Pairs(p,1:end-
1),Rules,MFN,MFType,UpBnd,LowBnd);
    K_p = P*b_x*(1/(b_x'*P*b_x+1));
    Theta = Theta+K_p*(Pairs(p,end)-b_x'*Theta);
    P = P-P*b_x*(1/(b_x'*P*b_x+1))*b_x'*P;
end
```

As you see, we use a function to calculate the b parameter. Here is the function:

```
MuoValue = zeros(size(Rules));
    for i=1:size(Rules,1)
```

```
        for j=1:size(Rules,2)
            MuoValue(i,j) =
CalculatingMuo(Data(j),Rules(i,j),MFNum(j),MFTyp
e(j),UpBnd(j),LowBnd(j));
        end
    end

    a = prod(MuoValue,2);
    b = sum(a);
    FinalB = a/b;
end
```

Results

Results for these parameters:

- Sigma: 100
- Number of Data Pairs: 250
- Number of Samples: 500
- Number of Membership Functions: 6
- Type of Membership Function: Gaussian
- Number of Inputs: 4
- Lower Bound: 0.2
- Upper Bound: 1.4

Mean Absolute Error: 0.0090

Mean Square Error: 5.9012e-04